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<div align="center">Lighting Assignment Report</div>

The purpose of this assignment was to load in a 3D object and to change the lighting around it with a spotlight and to shade the object with toon shading. The spotlight model had a light shining on my 3D objects and within the light cone, the objects are lit up. When the dolphins are inside the light cone, the Phong model is used so the model has 3D shading applied. The Phong model allows the objects to have a shiny component, which shows up when the model is near the light. Toon shading is a cartoon like shading model that uses different colors to represent the different distances from the light parts of the object are. According to this assignment, we were to use four different colors to represent the different distances. The different distances are figured out by how big the angle between the normal and the light position is. The smaller the angle, the brighter the color, and the larger the angle, the darker the color.

To calculate the spotlight model, you must calculate an extra vector. This vector is calculated by subtracting the point from the light position. I then normalized the vector with the light direction using the dot product and by finding the magnitude of each (vector and light direction) and multiplying them together. This is all done in functions and used in the spotlight model's fragment shader. The errors I encountered in the spotlight portion included wrong light position and my model flipped inside out. To fix my light position, I used a guess-and-check type of system, where I just moved my light around until I saw that it was shining on my model the

way I wanted it to. To fix my other issue, I had to change the glFrontFace method from clockwise to counterclockwise. This fixed all of my issues.

For the toon shading, the assignment called for the use of four different colors to change depending on where the model is located. To calculate the angles, I found the dot product between the normal and the light direction. After I found the angles I wanted, I used if else statements to make sure the angle was where I wanted it, and shaded the fragments the color I wanted within the if else statements. I had an issue with my intervals, but I was trying to shade the lighter colors first, so I switched to shading the darker colors first, and this fixed my issue. One other issue I had (it doesn't really fit into any category) was that my compile line wouldn't allow me to run my code. I had to remove a portion of it, and after I did that my code ran beautifully. Also, my dolphins are distorted due to the camera position I believe.

Spotlight area : 5.0

Location: (0.0, 0.0, 5.0)

Direction: (0.0, 0.0, -5.0)
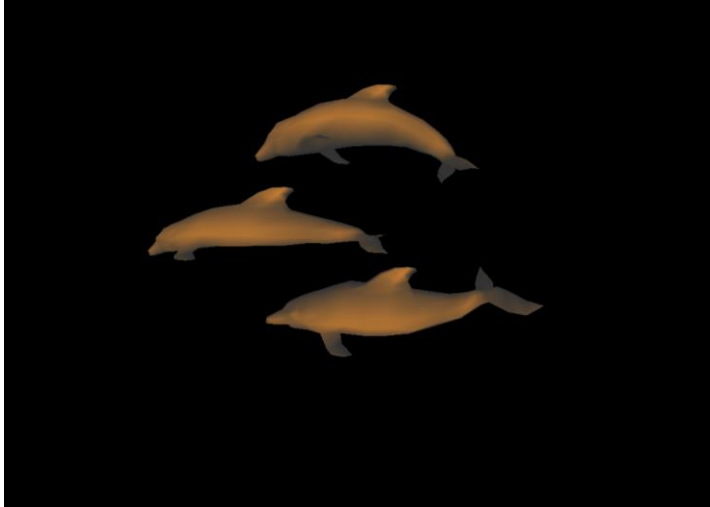
Spotlight area : 10.0

Location: (0.0, 0.0, 7.0)

Direction: (0.0, 0.0, -3.0)

Spotlight area : 2.0

Location: (0.0, 0.0, 10.0)

Direction: (0.0, 0.0, -6.0)